

Land rental markets and irrigation megaprojects: Political ecology of vulnerability and agrarian change in Colombia's irrigation megaprojects

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Abstract

Land rental markets often accompany irrigation infrastructure as improved water availability revalorizes land. Scholars of agrarian change critique land rental markets for contributing to capital accumulation and deepening disparities in resource access. To date, however, this approach has not incorporated the roles of environmental changes induced by irrigation, corresponding social-ecological interactions, and the political ecologies of vulnerability. Based on 12 months of research in Colombia's most expensive land rental market spanning two irrigation megaprojects, this paper demonstrates how land rental markets compound environmental stresses to exclude producers from agricultural livelihoods and advances debates regarding capital's continued detachment from land.

Keywords: *land rental market, exclusion, irrigation, political ecology of vulnerability, agrarian change, Colombia*

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Introduction

In recent decades, agricultural and development economists have posited land rental markets as a promising strategy for more equitable and efficient rural development in irrigated areas (Jin and Deininger 2009; Sadoulet, Murgai, and De Janvry 2001). By neoclassical economic logic, concurrently with the deregulation of land rental markets, increasing small- and medium-scale producers' rentals of irrigated land could be one solution to rural poverty (Deininger 2003). The proposal of land rental markets as a solution to inequality in irrigated areas, however, glosses over underlying structural causes of poverty, power imbalances of land and water control, and other forms of political-economic and ecological vulnerability.

Land rental markets are generally characterized by short-term leases as well speculative rental based on market fluctuations. Agrarian change scholars have typified and analyzed various arrangements of land control, but land rental markets have been largely absent from such debates (Peluso and Lund 2011; White et al. 2012; R. Hall, Scoones, and Tsikata 2017). Furthermore, scholarship on the inextricable linkages of land-water resources (Boelens, Gaybor, and Hendriks, 2014; Franco, Mehta, and Veldwisch, 2013; Mollinga, 2016) has yet to analyze the disparities in resource equity particular to regions dominated by social power-biased, shorter-term land rentals. Scholars of agrarian change critique land rental markets for contributing to capital accumulation and deepening disparities in resource access (Levien 2011; Goldman 2020; Andreucci et al. 2017; Andreas et al. 2020). To date, however, these approaches have not incorporated the roles of environmental stresses often experienced by producers in irrigated landscapes, corresponding social-ecological interactions, and the political ecologies of vulnerability (Bohle, Downing, and Watts 1994; Eakin 2005; Blaikie 1985; Chambers 1988).

In attending to land rental markets' social-environmental dynamics particular to irrigation districts, I respond to call to better understand how root causes of vulnerability interact with capital to drive rural transformation (Fairbairn et al. 2014). I integrate theoretical frameworks of the political economy of agrarian change and the political ecology of vulnerability to demonstrate how small producers face exclusion from land- and water-based livelihoods over time as they repeatedly experience mounting debt, variable water flows, insecure tenure arrangements and other pressures. I draw on Hall, Hirsch and Li's (2011) definition of exclusion, or "the ways in which people are *prevented* from benefitting from things (more specifically, land)" (7). This research expands the term to include exclusion from land-based livelihoods.

I examine dynamics of land rental markets and irrigation in two megaprojects in Central Tolima, Colombia. The Andean valley region is Colombia's most expensive land rental market, which spans two of the country's five largest irrigation districts. Advised by the World Bank (2004) that land rental markets would bring more agricultural production and equitable rural change, Colombian rural development officials continue to emphasize land rental markets' importance for economic growth (Fonseca Prada 2017). Three questions drive this research. First, what are the land tenure dynamics within the irrigation districts? Specifically, who, when, and why do producers rent-in or rent-out fields? Second, what are the principal environmental and economic stresses experienced by irrigators and non-

irrigators in the irrigation districts? Finally, how are environmental vulnerabilities and land tenure strategies borne differently across groups of irrigators?

The present case study follows in the steps of an important body of work on land and water inequities in Colombian rural development (Duarte-Abadía and Boelens, 2016; Escobar, 2012; Roa-García, 2014; among many others), a state that joined the twentieth century push towards mega-hydraulic infrastructure (Molle, Mollinga, and Wester 2009; Sneddon 2015) for both irrigation and hydropower with significant effects on local communities (Ulloa and Romero-Toledo 2018; Moreno and Montenegro 2021). In addition, the focus on irrigation and land in Central Tolima, considered Andean lowlands, joins a broader conversation on Andean irrigation infrastructure and its enmeshment with cultural and ethnic identities, state politics, and global environmental change (Mills-Novoa et al. 2017; Zimmerer 2011; Warner, Hoogesteger, and Hidalgo 2017; Mena-Vásconez, Boelens, and Vos 2020). In addition to theoretically working across the political economy of agrarian change, specifically land control debates, and the political ecology of vulnerability, this research also serves to further bridge the body of work on Andean irrigation infrastructure with discussions on agrarian change and land and water control.

Theoretical Framing: Integrating the political economy of agrarian change and political ecology of vulnerability

This research works across the frameworks of political economy of agrarian change and the political ecology of vulnerability to show how land rental markets especially in irrigated landscapes drive producers' exclusion from land and water-based agricultural livelihoods. This article offers a political - economic and -ecologic critique of land rental markets in Colombian irrigation projects to make three interrelated arguments. First, land rental markets advance capital accumulation through slowly excluding small- and medium- scale producers of their land, water use and livelihoods. Second and relatedly, land rental markets in irrigation districts constitute a form of land relations as well as land-water relations that provide capital with increased mobility through detachment from property ownership. Finally, I suggest that the development of large-scale irrigation infrastructure may create the social, environmental and political conditions for land rental markets, which may lead to increased patterns exclusion from land and water-based livelihoods for smaller producers.

Land control and land rental markets

Agrarian change scholarship provides key concepts around which to organize theories of land relations and attend to issues of inequality. Karl Marx's (1967) concept of primitive accumulation was defined by the separation of producers from their land and means of production, the resultant growth of the industrial labor class and the concentration of capital via the violent, forced enclosure of common or public land into private hands. Marx understood primitive accumulation as a historic process of creating the conditions for capitalist relations (see also Bernstein 2004; Sevilla-Buitrago 2015). Rearticulating and expanding Marx's primitive accumulation to reflect the neoliberal system, David Harvey argued that *accumulation by dispossession* (ABD) (2003, 144) is often not violent but works instead through financialization processes like debt and credit systems, slower and ongoing process of dispossession.

Scholars have since argued that now more 'advanced capitalism' expands through dispossessions including of private land and that the excluded or 'expulsed' producers (Sassen 2010) have few other labor options (Levien 2012). These arguments nuance previously essentialized classes of peasantry,

proletariat and capitalists. Similar to Marx's initial primitive accumulation, scholars insist that advanced capitalism also frequently works through land control, defined by Nancy Peluso and Christian Lund as "practices that fix or consolidate forms of access, claiming and exclusion for some time" (2011, 668). Here I examine processes of capital accumulation and exclusion through speculative land rental markets within irrigation districts, in which rental values are market-driven, fluctuate widely, and may be higher than the land's actual use value. I draw on Hall, Hirsch and Li's (2011) definition of exclusion, or "the ways in which people are *prevented* from benefitting from things (more specifically, land)" (7). In what follows, I expand the use of the term to include exclusion from water, and more specifically from land- and water-based livelihoods. Such exclusion is unevenly experienced by various rural residents based on age, gender, class, and other social differences.

Land rental markets have received limited attention within literatures of agrarian change. The characteristic short-term leases by producers themselves contrast with recent focus of agrarian change literature on land grabs, broadly understood to be large land deals moved by corporate capital (White et al. 2012; Kay 2015; Borras and Franco 2012), or the growing interest of farmland as a financial asset (Birch and Muniesa 2020; Fairbairn 2020). Rental markets differ in three principal aspects. First, land control in land rental markets is not always an abrupt, often violent or state-supported dispossession of land, as in land grabs.¹ In contrast, the presence of large groups of landless producers interested in renting land points to historic processes of dispossession underway. Second, mechanisms of capital accumulation in land rental markets often occur through small-scale acquisitions or rentals of fragmented fields, the dynamics of which are understudied in agrarian change literature (D. Hall 2013). Finally, in the cases of Espinal, Saldaña and Purificación in Tolima, local, principally producer-actors control the land ownership and rentals in contrast to corporate or transnational capital.

Important for capital accumulation, contract farming (Pritchard and Connell 2011; R. Hall, Scoones, and Tsikata 2017; Carney 1988) and, as I will argue, land rental markets, permit capital to selectively adapt to landscapes, environments and institutions. The contingent nature of contract farming or rentals permits companies to eschew environmental risks, and to instead shift the costs, risks and responsibility onto smallholder farmers (de la Cruz and Jansen 2018) and move the contracts to new landscapes. Moreover, scholars have argued that land relations such as contract farming serve to move capital's dependence away from land and into technology, machinery and processing industries, thus increasing its mobility, what Sukhpal Singh (2002) calls 'substitutionism.' Such agrarian contexts complicate narratives of capital's disposessory force often framed as capitalist versus peasant farmer, directing analytical attention instead to more subtle processes of agrarian change than those of large-scale, rapid and violent enclosures (D. Hall 2013; Borras et al. 2018).

In the research that attends to land rentals, scholars emphasize diverse forms of rentiership and resultant inequalities in the evolution of capitalist relations. Rentiership is the capture of rent through owning increasingly more land. For example, Karita Kan (2019) posits speculative rentiership, or real estate deals in peri-urban areas with inflated housing rentals as a new form of ABD. In another case, Michael Levien (2012) argues speculative rental property relations within Special Economic Zones are a form of capital *involution*,² in which "exchange displaces production and a dispossessed peasantry looks, with very unequal success, to opportunities for rent, interest and mercantile profit" (965). In other

¹ Although Levien 2012 suggests rental markets are often state-backed.

² Drawing from Burowoy (2001, 270).

words, agricultural production gains become second to the speculative renting of land. In contrast to Kan, Andreucci et al. (2017) contend rentiership differs from capital accumulation. In their argument, Andreucci et al. understand accumulation to occur through "expanded reproduction"; rent relations constitute a form of *value grabbing* in which property relations "extract value" instead of "[producing] new commodities" (29). In other words, value is not created but appropriated in rent relations. My research occupies a distinct starting point by focusing not on rentiers and value-grabbing through renting-out, but instead by directing attention to the varied actors and experiences of renting-in land. Such a perspective further nuances understandings of capital accumulation and land rentals by demonstrating the appropriation of value through renting in or tenancy, not only through ownership.

Political ecology of vulnerability

Finally, to tease apart the "context, terms of contestations, mechanisms and stakes of control" (Peluso and Lund 2011, 668) within Tolima's property relations and the uneven experiences of exclusion among the rental market's participants, I draw scholarship of political ecology, and more narrowly, the political ecology of vulnerability. Political ecology-informed frameworks analyze social power relations with explicit attention to biophysical factors influencing the same (Zimmerer 2003). Scholars have long employed political ecology to examine how interacting economic, ecologic, discursive and cultural forces create unequal power relations within irrigated landscapes (Birkenholtz 2016; Boelens et al. 2016; Carney 1991; Harris 2008; Zimmerer 2000). Political ecology informs myriad conceptual approaches employed to critique water use and access, including in the Andean region, such as hydrosocial territories (Hommes et al. 2018; Damonte and Boelens 2019), rights-based frameworks (Rocha López et al. 2019; Mena-Vásconez, Boelens, and Vos 2020), and water justice (Zwarteveen and Boelens 2014; Boelens, Perreault, and Vos 2018), among others.

This research draws insights specifically from the political ecology of vulnerability approach which forms one thin branch of the "tree with deep roots" that is political ecology more broadly (Robbins 2012). As critical agrarian change frameworks elucidate disproportionate effects of or differentially experienced forms of ABD in rural regions (Chen 2013; Levien 2017), a complementary political ecology of vulnerability framing enables necessary attention to environmental factors (Birkenholtz 2012). The political ecology of vulnerability investigates "the social and political-economic production of marginality and associated risk" (Ribot 2011, 1160) by integrating analyses of "social structure, human agency and the environment" (McLaughlin and Dietz 2008: 104). It illuminates how populations with less social power are disproportionately harmed by power through institutions and social practices as well as ongoing, chronic environmental stress, such as increasing temperatures due to climate change or variable water flows (Eakin and Luers 2006).

Vulnerability assessments, when framed by political ecology, seek underlying causal explanations for the increased exposure to and sensitivity of populations to stresses and risks, as well as for their weakened capacity to cope with the same (Ribot 2014). Scholars attend to structural and discursive relations as well as intersectional identities that create and reproduce vulnerability (Luna 2019) and socio-environmental interactions that can increase exposure or decrease capacity (Birkenholtz 2012). A political ecology of vulnerability approach is necessary to fully capture differentiated vulnerabilities of participants within the agricultural land rental market given the important impacts of biophysical aspects on social reproduction within an irrigation district.

In irrigated landscapes, forces including water availability, increasingly variable precipitation and pest and disease crop damage can cause insurmountable damage to the livelihoods of farmers already experiencing socio-economic or other vulnerabilities. Such chronic and ongoing environmental stresses further compound risks of the political economic system such as fluctuating market prices or changes to government crop subsidies (de la Cruz and Jansen 2018; Eakin 2006), creating experiences of 'cumulative vulnerability' (Ferring and Hausermann 2019). Environmental or infrastructural variability in water provisioning can lead to crop losses that may devastate the family economy of a small producer managing one field of a few hectares of one crop. A more economically powerful producer, however, may have multiple, larger and more diversified landholdings and other resources that enable more resilience in the face of water shortages (Taylor and Bhasme 2021).

Differing from most studies of agrarian change, this research analyzes how persistent vulnerabilities intersect with involvement in the land rental market and issues of water availability and other environmental stresses. More precisely, I examine how broader political economic structures coupled with environmental vulnerabilities create and maintain vulnerabilities and disparities in access to land both in the form of tenancy and ownership. Importantly, engaging vulnerability through a lens of political ecology encourages close attention to individual land users' experiences of environmental stress and the uneven success found in irrigated land rental markets. In doing so, I advance agrarian change literature's understandings of land control, exclusion from land-water based livelihoods and mechanisms of capital accumulation via irrigated land rental markets.

Methods

Research occurred throughout one year of in-site research in Usosaldaña and Usocoello, neighboring megaprojects in Central Tolima. I examined the intertwined complexities of land rent, water availability, and socio-environmental vulnerabilities through a mixed methods approach of 176 household surveys with producers, 44 interviews with producers and irrigation officials and participant observation within the administrative offices and events of the megaprojects' two water user associations (WUA).

Participant observation was ongoing between March and August 2019 within the Offices of Operations at the administrative offices. Activities included regular presence in the offices, accompanying canal workers to check water levels and adjust irrigation gates, observing meetings between irrigators and operations staff, accompanying staff to farms to resolve conflicts between neighbors and observing problem-solving between engineers and operations staff about system maintenance and construction. Additionally, I regularly attended WUA-wide events including the yearly meeting of registered irrigators, WUA-sponsored protests, festivals, parades and community education workshops on climate change.

Along with participant observation, I conducted household surveys and semi-structured interviews to gather details about producers' experiences of stress, diverse land tenure arrangements and livelihood activities. Household surveys served to gather a broader set of evidence on rental and ownership arrangements related to crop choices. Surveys gathered data on rental prices and various forms of stresses experienced by a wider swath of producers than would have been possible through interviews. A total of 176 household surveys were completed, with 94 from Usocoello irrigators and 82 from Usosaldaña. Given the safety constraints of conducting research in a more rural, post-conflict area with ongoing threats of violence from organized criminal groups, the surveys were conducted primarily

within the WUA offices.³ The sample was organized with support from districts' Operations Teams to capture responses from producers of differing age, gender, land tenure and size of landholdings. Additionally, I surveyed and interviewed non-irrigator producers in both districts to represent a diversity of cropping systems and water use land tenure arrangements.

Semi-structured interviews (36) probed producers' histories of cultivation in the area, perceptions of the region's difficulties and strengths and decision-making processes regarding land tenure and choices of cropping system. Eight additional in-depth interviews were divided among government officials, irrigation district staff and presidents, local environmental activists, and leaders of national agricultural unions and irrigation federations. The interviews broadened the context of market, environmental and social vulnerabilities in relation to agricultural production in Central Tolima. All informants' names have been changed to ensure anonymity.

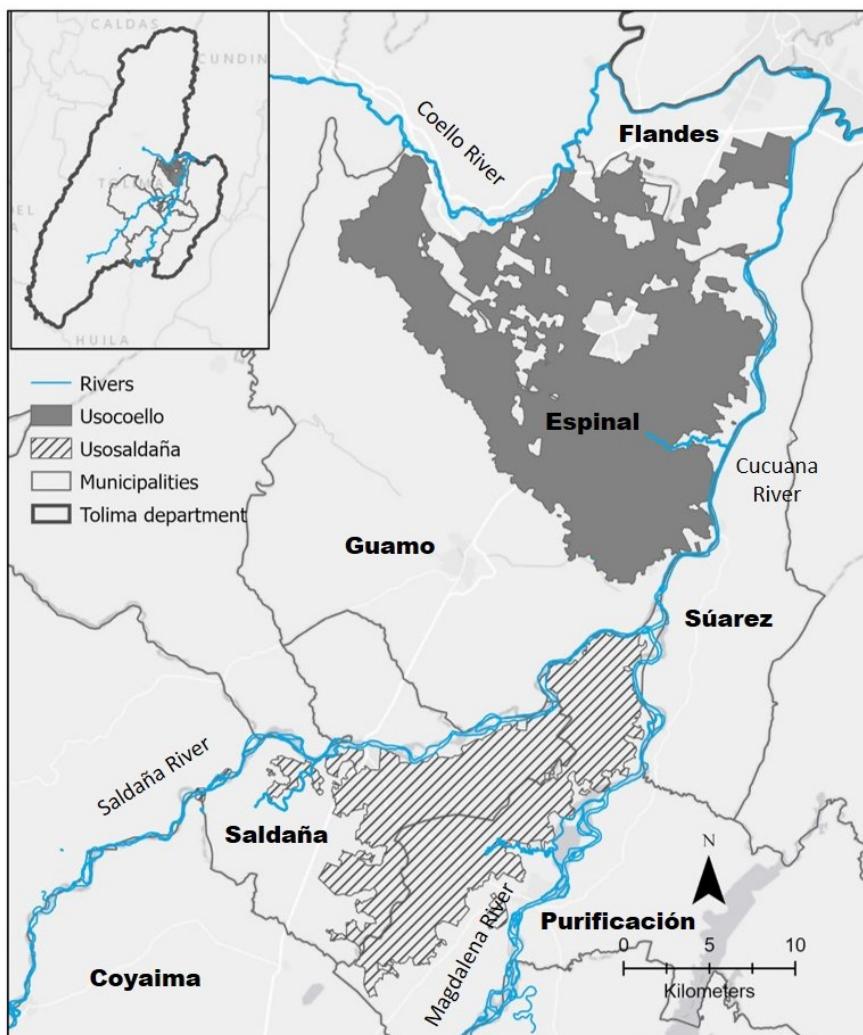
Results I: Central Tolima's irrigation megaprojects: Land extension, water management and crop rotations

The Andean lowlands of Central Tolima form one of Colombia's agricultural production centers, contributing significant harvests to domestic markets of paddy rice, maize and cotton, among other crops. The region is 150km or four to five hours from Bogotá, Colombia's capital city and food system hub. For at least 150 years, settler Colombians have capitalized on the region's central location, flat valley topography, 10-12 hours of daylight and arid climate for agricultural production. The problem of water availability was solved during the mid-twentieth century, when Colombia developed multiple megaproject⁴ river diversion canal irrigation systems.

Figure 1. Usocoello, Usosaldaña and surrounding municipalities.

³ As all producers are required to enter the WUA offices to schedule water or seeding, there was an extensive and diversified sample selected. Due to histories of and ongoing conflict and violence in this area, administering a door-to-door or randomized sampled survey was not possible. Some parts of the study area had active paramilitary activity and violence during the early 2000s by the *Bloque Tolima* paramilitary unit. During the period of data collection, communities and individuals in the region received ongoing threats from other paramilitary groups, including the *Aguilas Negras*.

⁴ An irrigation megaproject is defined by Colombia's Rural Agricultural Planning Unit, *Unidad de Planificación Rural Agropecuaria*, or UPRA, as more than 5,000 ha. For more expansive discussions of megaprojects, see Gutierrez, Kelly, Cousins, and Sneddon (2019).



Map by author.

The two under examination, Usocoello and Usosaldaña, divert water from local tributaries of and drain into the Magdalena River (Figure 1). Usocoello administration and irrigators regularly boast that it is Colombia's largest irrigation district, irrigating more than 25,000 hectares (ha). Usosaldaña irrigates more than 14,000 ha. The two are among the country's five largest irrigation districts and, thanks to the diverted water, have been called the heart of Colombia's paddy rice production. In 2019, Tolima's rice harvests comprised about one-third (27%) of the country's rice production⁵ and intensive production earns it the country's highest yields of 7.9 tons per hectare (tons/ha).

Notwithstanding their similarities in design and focus on paddy rice as the region's principal crop, Usosaldaña and Usocoello differ in water allowance, water allocation rules and, consequently, diversity

⁵ DANE. (2019). Encuesta nacional de arroz mecanizado. Accessed at <https://www.dane.gov.co/index.php/estadisticas-por-tema/agropecuario/encuesta-de-arroz-mecanizado>

of cropping systems. First, despite its larger extent, Usocoello has a smaller total water allowance from two rivers with more variable flows, the Coello and Cucuana rivers. In comparison, Usosaldaña diverts water from the abundant flows of the Saldaña River (Table 1, Figure 1). Second, the districts' water allocation systems differ. Usosaldaña has standardized, regular rotations, with all producers receiving water for three to four days, then passing another three to four days without water. In contrast, producers in Usocoello enter the operations offices to ask for water each day it's needed. In other words, Usocoello aspires to always maintain sufficient water levels in all canals, with canal workers opening individual sluice gates in morning or afternoon shifts, whereas Usosaldaña shifts water levels in its main canals from one area to another every few days.⁶

The water allowances and differences in land extension link to crop management regulations. Most fields in Usosaldaña have produced rice consistently for more than thirty years, harvesting twice annually, with many producers citing rice production since the 1980s. In contrast, Usocoello's more extensive area of influence and more restricted water allowance translates into more varied cropping systems, with histories of sesame, cotton and tobacco production and pockets of perennial fruit production. To best distribute and manage the variable flows, the Usocoello WUA enforces mandatory crop rotations between rice harvests. Practically, this means that each field registered to receive irrigation water may only sow rice one semester per year. In between rice harvests, users sow dry ("secano") crops that are less water intensive, usually either cotton or maize. Significant for the discussion that follows, the semesterly shifts in crops contributes to a more dynamic land rental market in Usocoello.

⁶I found no significant difference between head- and tail-end irrigators.

Table 1. Statistics of irrigation projects Usocoello and Usosaldaña.

	USOSALDAÑA	USOCOELLO ⁷
Year district started to operate	1953	1953
Year district transferred to water user association (WUA)	1976	1976
Complete title of WUA	Asociación de usuarios del Distrito de Adecuación de Tierras de gran escala del Río Saldaña	Asociación de usuarios del Distrito de Adecuación de Tierras de gran escala de los ríos Coello y Cucuana
Municipalities served and their respective populations	Saldaña: 14,099 Purificación: 22,682	Espinal: 67,983 Flandes: 27,334 San Luis: 12,139
River(s) diverted	Saldaña River	Coello and Cucuana Rivers
Intake of water (cubic meters per second):	Saldaña River: 25	Coello River: 9.8 ⁸ Cucuana River: 10.9 ⁹
Area of influence	14,119	29,842
Hectares irrigated in 2018	13,912	25,038
Registered irrigators in 2018	1,413	2,022
Principal crops	Rice	Rice, maize, cotton
Hectares seeded in rice, Semester A 2019	11,350	11,614
Hectares seeded in <i>secano</i> (not-rice), Semester A 2019	Data not available.	18,425
Governance structure of water allocation to irrigators	Irrigation water on constant rotation to users every 3-4 days.	Irrigation water requested daily. On rotation during low river flows.

Water availability and shortages: System differences, environmental vulnerabilities and power dynamics

Due to the variability in water flows and differences in the systems' water capture and distribution, surveys demonstrated diverse experiences between the districts' irrigators regarding water shortages and linked environmental stress. In survey results, Usocoello irrigators answered yes, they had experienced water shortages or insufficient water in the canals, while few Usosaldaña producers mentioned a lack of water. Vividly demonstrated just weeks prior to administering surveys, extremely low river flows in the Coello and Cucuana Rivers had forced Usocoello into emergency rotations ("rotaciones", as called colloquially). Nearby Usosaldaña, on the other hand, had no water shortage. In Usocoello, rotations were scheduled closings of canals to strategically move the limited water supply throughout the district. Rotations followed a previously set schedule: each irrigation sector had four days with water, three days without.

⁷ Data from WUA administrations unless otherwise noted.

⁸ Suministro de agua en Tolima está destinado solo a los arroceros (2016, February 25), *CONtexto Ganadero*. Retrieved from: <https://www.contextoganadero.com/agricultura/>

⁹ Usocoello terminó de pagar el distrito y se prepara para combatir el cambio climático (2020, January 27), *El Nuevo Día*. Retrieved from: <http://elnuevodia.com.co/>

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The rotations in early May 2019 fell at a particularly inopportune time for Usocoello irrigators. Many were soon to sow or had recently seeded rice. Without water, they might miss the window for sowing or could lose the money already invested in seed and labor. Similarly, maize producers were desperate for water, as the district's thousands of hectares of maize were tasseling, a process requiring consistent and plentiful water. Desperate, one irrigation administrator told me, "If we don't have enough water, this district will lose millions and millions of pesos already invested in field preparation, seeds and inputs."

To plan for such a crisis, the district had a pre-determined calendar to guide the rotation of water through the principal canals. The calendar was immediately printed and delivered to the operations' office. As the operations team met to plan closing canals and calculate how much water remained, irrigators lined up behind the closed door, shouting and pushing to enter the office and demand water. The more socio-economically powerful irrigators assertively entered the office and refused to accept the calendar rotations, instead demanding the canal workers open their respective canals (a similar account is found in Mollinga 2016:1320). The smaller-scale, landless renting irrigators waited quietly in line, worried their recently seeded field or two would not germinate. I took their names, irrigation member codes, updated phone numbers, and sowing dates for the operations staff who also hoped to bypass the set calendar and instead prioritize producers' needs. Despite having an established, systematized calendar, the operations team was forced to negotiate the power relations of irrigators' socio-economic and social capital. Although I was not privy to final reasoning for which canals to close first and why, the hours spent in the operations offices that week illustrated the social power divides present in the WUA and the power relations tied to irrigation water and hectares in cultivation.

Results II: The land rental market in Usosaldaña and Usocoello: Prices, length of contracts, and cropping systems

Table 2. Survey participants' reported rental prices per hectare in 2019, by irrigation district.

Cost of field rental per hectare per semester in 2019, as reported by 22 survey participants. (in thousands of Colombian pesos)		
Usosaldaña	Usocoello (rice)	Usocoello (secano)
1000	2000	800
1200	1800	700
1200	1800	1000
1200	2000	800
1200	2000	800
1200	2100	800
1300	2300	400
1500	2000	800
1700	2000	800
1750	2000	800
2000	2000	1000

Access to irrigation water was mediated in Central Tolima by an exorbitantly costly land rental market. Survey participants reported land rent per hectare per semester (/ha/semester) for rice was valued at two million COP while renting for maize or cotton (*secano*) crops cost 800,000 COP (see Table 2 on rental prices per crop) due to a lower market value. All producers in a district generally paid the same price per hectare in land rent, with few exceptions. At times, however, the prices between districts varied. In 2019, the prices of land rentals in Usosaldaña were markedly lower than in Usocoello. When asked why, key informants commented that Usosaldaña fields had poorer soil quality given the lack of crop rotations, requiring more fertilizers and herbicides to combat weed problems. By 2021, the price differences between the districts were nonexistent; informants quoted Semester A 2021 land rent prices in both districts at approximately \$760 USD. This demonstrates an increase of \$240 USD/ semester compared to 2019 Usocoello prices.

Among irrigated regions in Colombia, Central Tolima has the highest land rental prices as a portion of cost of production. In 2003, a table of the cost of production of rice listed Tolima land rent as comprising more than 30% of the total cost of production, while in other regions of paddy rice production like Meta, rent was 11% of the total cost (Agrocadenas, 2005). In 2018, the Central agricultural region, which includes Tolima, remained the region with the highest prices of land rent, constituting 21% of production costs. The prices reported by survey and interview participants (Table 1) were even higher than government data.

For rice production, the local rule of thumb was that one would have to harvest at least 120 *bultos*, or six tons, of rice per hectare to earn an acceptable profit given the costs of production: water tariffs, seed, land preparation, agrochemicals and labor.¹⁰ Many producers did not meet that goal, reporting in surveys harvests of 80 bultos/ha with few reporting over 140 bultos/ha. Of the 47 surveyed rice producers that reported their harvests per hectare, only 16, or about one-third, reported harvesting more than 120 bultos/ha. Yet producers continued renting-in fields and producing for multiple reasons. They hoped rice prices would improve, earning them substantial profits. Others continued because rice or maize was the agricultural system they knew and transitioning to another requires great capital. Still others, especially highly skilled agricultural workers but with little formal education, felt they had few to no other livelihood possibilities. They hoped to earn something from the rice harvest, even if small.

Land rentals for irrigated agricultural production were widespread. The 2017 Census of Rice Producers recorded whether registered rice producers cultivated as renters or owners of fields. In 2016, the census counted 541 of 699 rice producers in Usocoello as renters, or 77%. In Usosaldaña, 1556 of 2627 producers were renters, or 59% (Table 3). Rental contracts were often for one year in Usosaldaña, where most fields yielded two rice harvests per year. Rentals were more dynamic in Usocoello, where irrigators were required to rotate *secano* crops between rice harvests, to balance the water supply. Given the crop rotations, some rental contracts were semester-long, or for the *secano* or rice semester only throughout consecutive years. Tenancy agreements in Central Tolima are most often formalized in writing, with signed and notarized contracts specifying the length of time and price of the rent.

Table 3. Counts of renters and landowners by registered rice producer (unidad productor arrocero) relative to total hectares producing rice in the second semester of 2016.

Source: 2017 Fedearroz Census of Rice Producers. Available at <http://www.fedearroz.com.co/>

Municipality/Region	Espinal	Flandes	(Usocoello) Espinol + Flandes	Saldaña	Purificación	Usosaldaña (Saldaña + Purificación)	Tolima Total
2016B area under rice cultivation (ha)	5840	979	6819	5948	8443	14391	54862
2016A producers UPA (no.)	654	45	699	954	1673	2627	5323
Landowners	151	7	158	411	627	1038	1846
Renters	503	38	541	527	1029	1556	3441
Other tenure arrangement	-	-	-	16	17	33	36

Surveys and interviews evidenced renting-in land as the social norm, with small, medium and large producers renting-in fields. Importantly, renting-in and owning land were not mutually exclusive in the region, as some producers cultivated both fields they owned and additional fields rented-in. Both the largest and smallest producers interviewed and surveyed rented-in fields, regardless of land ownership. Among survey respondents, for example, 23 of 116 (19.8%) survey respondents both owned and rented-in fields. Among those that rented fields, the median acreage was 8ha of rented land per person, with an

¹⁰ Most rice producers in the region relied primarily on day laborers (*jornaleros*), whose 2019 daily rate was \$40.000 COP (\$12 USD) plus lunch. I met a few producers that worked alongside the day laborers. Generally, labor was not supplied by the family, meaning labor was a significant portion of the cost of production.

average of 52.9 ha. The numbers suggest very few producers rent-in hundreds of hectares, but that most rent-in 10 or fewer hectares in total.¹¹

Results III: Landless and smallholder producers' social-environmental vulnerabilities within the irrigated land rental market

Participation in Central Tolima's land rental market, both as landowners leasing-out fields and tenants renting-in fields, was widespread among small, medium and large-scale producers. Yet, the experiences of precarity and the reasons for renting-in and renting-out fields varied significantly and were unevenly experienced across intersecting social differences of socio-economic standing, age and gender in particular. Less powerful producers, especially landless producers or those with small landholdings, retired smallholders, or women with significant caring responsibilities experienced the most insecure incomes amidst the land rental market.

Smallholder producers

Andrés, a man in his early 70s, had grown *secano* (maize, cotton, sesame) crops within Usocoello for more than four decades. He owned four hectares, two historically sown in *secano* row crops and two hectares of fruit orchards. "I split the fields to ensure income in the event of water shortages," he told me. When I asked how his income was, he told me he always felt behind. "I harvested and harvested and harvested, seven, eight or even five tons/ha and you see the price of maize right now – \$220 USD/ton. Like right now [prices are good because] fresh corn is worth money [because it's off-season], but when the greater harvest comes, prices drop." Given the seasonal fluctuations in price, small-scale producers without grain storage infrastructure were unable to take advantage of high prices in the shoulder seasons, in which more variable precipitation and temperatures made production riskier.

In recent years, age-related health problems inhibited his ability to work in fields. He rented-out his fields to two different producers: one that produced rice and another that cultivated and sold fruit from the orchards. Although the rental income permitted the man and his wife to maintain their small, simple home in Espinal, their socio-economic position was quite precarious. The minimum salary set was \$208 USD/month, or \$2,496 USD/year, in 2019. The rental income earned the family \$2,160 USD/year, less than one minimum salary. That amount stretched to cover WUA tariffs and fees, medical bills, property taxes and supported he and his wife as well as another dependent. Given the generally fixed price of rent per hectare region-wide, and the family's need for income and precarious socio-economic and health position, they had limited power to negotiate higher rental contracts.

Other smallholder producers also invested in fruit production, as it required less expensive machinery and were less dependent on water availability, and hence less risky. I interviewed nine smallholder producers that owned 0.25 – 2ha sown in mango, lime, guava or intercropped perennial fruit crops. They told me the orchards withstood water shortages and climate stress better than row crops so seemed a better long-term investment. Five rented additional fields for rice or *secano* production, unable to earn sufficient income from mangoes and limes. In 2019, mango producers received from

¹¹ Survey numbers on total acreage and field counts of land rentals here provide an illustration of the dynamism of the institution of land rentals but cannot be understood as absolute numbers. It became apparent and confirmed by irrigation officials, that many survey participants under-reported their rentals. Some survey participants feared our data would reach the Colombian tax authorities, so may have under-reported their rental numbers.

intermediary purchasers \$1-2 USD/20 kilos (*guaca*). For families that harvested 6-8 *guacales*/day, income was extremely limited.

Others just decided not to harvest mangos. One producer said, "They're paying \$1 USD/basket of mangos and then the basket itself costs 50 cents USD, and then you have to pay the person that's harvesting the mangos, so people are just not harvesting them." To the point, another producer lived on two hectares of mango trees reported that he had stopped harvesting mangos. He told me the cost of paying one day laborer to climb the trees to harvest mangoes was \$20 USD plus lunch, almost twice as expensive as rice day labor pay (\$12) due to the danger of and expertise needed to climb mango trees. He and others explained that despite not harvesting, they were keeping the land because they had no other options. It was preferable to keep the land and search for day laborer opportunities for themselves.

Notably, I met various women who managed their family's land by renting-out fields while also performing care labor for parents and children. I spoke with Lucía, the daughter of a small producer of rice and maize, who managed renting-out her elderly parents' field of 1.5 hectares. I asked how her parents earned enough money when she was younger. They had rented-in an additional two fields for a total of 10.5ha of paddy rice. When I asked why they had stopped renting, she recounted a significant crop loss that impacted her family in the early 2000s. The three fields were hit by a bacterial disease.

"We lost \$750 USD per hectare," she told me, "The bacteria hit the crop and we applied so many agrochemicals because that's what one does with disease. We did three applications. Every week it was applying more and more, and those inputs being so expensive, of course whatever profit we did earn had been spent on agrochemicals."

Her family had no other income options at the time. While environmental stresses affected all producers, the impacts were felt more intensely by small producers who cultivated rented-in fields, as crop losses further compounded high prices of agrochemical inputs and steep rental prices.

In 2019, Lucía cared for her aging parents and is a single mother of two, both in college. She stretched the income of her part-time, temporary job to cover her parents as well as her two young daughters. She administered her father's 1.5ha field, renting it to a medium-scale rice producer. The rental money grossed her \$1,010 USD annually, less than one-half of a minimum salary. She worked any short contract jobs possible to complement the rental income. Since I met her in 2019, she has worked as a nurse aid for a person in hospice care, an enumerator for local survey companies and proudly told me she put her daughters through school by regularly preparing and selling the traditional dish of pork and rice (*lechona*) for events. While renting-out land did provide an income to smallholder families like these, many families continued to struggle financially.

Families like these rented-out to small-scale producers but also fielded propositions from more powerful producers. A second woman in a similar position earned rental income from her parents' three fields totaling 10ha. While I ate dinner with her family one night, a large-scale rice producer called, asking if she would rent her land to him. She told him she was happy with the renter she had now. He insisted, asking her what she earned per hectare. She thanked him for his interest and ended the call. I asked about the caller. "He's a larger landowner in the area," she told me, "He's always trying to rent more land." I inquired if these calls are normal. "Yes, I receive a few calls like this every season, but we've

been renting to the same man for many years. We are not going to change." Larger landowners rented-in fields from smaller producers, looking for additional space where possible.

Owning land in whatever quantity remained an important asset for families, even if rental income was limited. There were few job opportunities outside of agricultural production or the service industry. The unemployment rate in Espinal hovered around 50% between 2011-2014. In the municipalities irrigated by Usosaldaña the unemployment rate was more than 56% during the same period.¹² Opportunities for women's employment were few within the male-dominated agricultural business. Women that were not agricultural producers sought work where possible including in stores, care labors, or in administrative or service positions. Women faced more precarity than men and experienced unemployment, even in the informal sector, at rates far above men (Castro Güiza and Lozano Martinez 2012).

Landless producers

Landless producers exclusively rented-in fields during non-rice semesters to cultivate maize and cotton. For landless tenant producers especially, the high prices of land rent combined with environmental stresses and the low market prices for non-rice crops made production difficult. **Furthermore, despite rental contracts' formality overall, tenants with little social power were at the whims of landowners' decisions.** I interviewed one landless tenant producer named Manuel. We met at an empty field occupied only with a building's early foundations. He pointed to the field, "I had rented this plot of land. But the owner sold the plot of land to a developer and didn't tell me. They cut down my cotton crop. I lost everything I had invested – labor, seed. I lost about \$9,000 USD". This had happened on two separate occasions. Once years ago, and then in February 2019, months before I interviewed him.

Gabriel, a small-scale producer of yuca and lentils, crops not requiring significant amounts of irrigation water and consequently with a lower cost of production, had rented-in a two-ha field for many years. He paid \$240 USD/hectare/year in rent, an especially low amount in the region. Gabriel told me he had maintained a good relationship with the landowner during years, and perhaps the low rent was due to their relationship. But in 2019, Gabriel recounted, the landowner was approached by a prominent rice producer who wanted to pay the going rate of at least \$510 USD/hectare/semester. Gabriel lost that land. Less socio-economically powerful producers, especially those with little to no landownership, were increasingly unable to maintain agricultural livelihoods in the face of rising land rental prices.

I interviewed Gabriel in May 2019 as he planned how to earn a living without the income from yuca and lentils. For the time being, he had a small patch of lentils for subsistence, and collected mangos daily to sell. I asked if he would sell his house, situated on one-fourth hectare. He responded, "[This land] is the only thing I have to live by, with the mango trees and the plantains and I have some yuca. One can't sell those...Try to tell me how much that's worth, how to convince me to sell it!" Although excluded from production at a larger scale and struggling to maintain income for his household, Gabriel, like the mango producers previously mentioned, refused to sell the small piece of land of their homes.

¹² Data from reports from the Gobernación del Tolima entitled "Estadísticas: 2011-2014", separated into three reports for municipalities Espinal, Saldaña and Purificación. Published by the Gobernación del Tolima with support from the Universidad de Ibagué in 2015. Available at www.tolima.gov.co. More recent municipality-level unemployment numbers are not available. Numbers measured against those residents deemed "economically active" (not children, students or elderly). There was no gender disaggregated data.

A third vignette, Carlos was a landless producer renting-in multiple fields. Carlos' father had grown sorghum, tobacco and maize on land he owned in the 1970s until the early 2000s. When sorghum and tobacco markets disappeared in the early 2000s, his father sold their land. Carlos rented 30ha for maize production in early 2019. Due to mite damage, he lost half of the harvest, 15 ha, worth approximately \$9,000 USD. He managed to pay off the credit for seeds and inputs (agrochemicals) but was in debt to the landowner for a portion of the rent.

Feeling there was no option but to take out credit to continue producing, hoping for better environmental and market luck, in the second semester of 2019 Carlos was trying again. He rented-in two fields for cotton production (2.5 and 3 ha) and one for rice (2 ha). He sold the mangos and guavas that grew around his house (2 ha) for a few extra dollars. To make ends meet, he also owned a business of applying agrochemicals, hiring day laborers to work in large fields for herbicide and pesticide applications. Financially stressed during our interview, Carlos said, "These days I might net \$50 USD per hectare [of rice I cultivate]. But I work with machines [for applying agrochemicals], so the next week I might need to invest \$30 in fixing a motor, \$16 in another and then the money is gone." As a producer that exclusively rented-in, Carlos had no financial safety net and was trapped in a cycle of credits, debts to landlords, and gathering earnings from wherever possible.

I asked him how life might be different were he to own land. He replied,

"It's really costly [to properly prepare land for paddy rice production]. A landowner can have his field in bunds, prepared properly for rice, because it's his, with good water and his own machinery, and landowners can [lazer] level their fields as they would like. But for example, if you were to rent-out a field to me and I were to invest in bunds well then, the next season you refuse to rent to me, someone else would benefit [from my investment and I would lose out]."

Ultimately, despite the formal rental agreements, tenants were in vulnerable positions. The short-term contracts and high rental costs dissuaded less powerful tenants from investments in infrastructure or land preparation (i.e. leveling or creating bunds for rice production) which could result in higher yields. Environmental stresses of pests and disease linked to economic stresses of paying rent and high costs of production. Landowners, especially larger landowners, and those with more socio-economic capital garnered better profits within the irrigation district.

Results IV: Land rental market benefits power producers: Environmental risk mitigation and crop portfolio diversification

Landowners and larger-scale producers accumulated more wealth through the ability to diversify crops, construct processing infrastructure, and rent-in fields strategically. Ability to purchase land or rent significant acreage permitted producers to embrace diversified crop portfolios or construct permanent grain processing or storage infrastructure like silos, and thus own some of the means of production, to mitigate inevitable market fluctuations. The largest producers owned all necessary machinery for paddy rice and large-scale maize production. They had offices, secretarial and financial teams, managers of cultivation regions, and agronomists on staff. They operated at an entirely different scale than small-scale or landless producers.

Notably, these largest landowners were also often the largest tenant producers, renting five or six times the amount of land they owned (Table 4). Differing from rentiers, these powerful actors did not generally rent-out land. Similar to small-scale producers like those that owned orchards, although with much less risk, renting-in permitted large-scale producers to move their operations to best capture profits. For example, one producer came from a wealthy landowning family, residents of the region since the 1940s. In 2019, he cultivated more than 2,500ha with fields in various irrigation districts throughout Central Tolima. An expert in paddy rice production, he cultivated 400ha in Usocoello where water was relatively cheaper at \$150 USD/ha/semester, both owning and renting, and cultivated other owned fields totaling 79ha in a neighboring district with fees up to \$300 USD/ha. Owning the machinery for paddy rice production, he transported it between regions, enabling lower costs of production.

In addition to diversifying production across districts, renting-in land hedged against environmental risk, permitting crop diversification and easy adjustments to cropping systems. A producer in his late 60s grew up in a different department and completed his agronomy degree in the study region. He bought land to produce maize in the 1980s with a colleague, and continued accumulating rented and owned fields. In 2019, he reported owning about 300ha and renting-in an additional 800ha. On the owned land, he reared cattle sold through direct sales and had a mango orchard wholesaled through contracts. Rice and maize production, the man's expertise, occurred on rented-in fields. The shorter contracts made possible a quick change if market prices dropped or if water flows fluctuated. Compared to rice and maize, cattle and mangos were less risky investments. They were not dependent on irrigation district water sources, mangos were less prone to extensive crop loss due to pest or disease, and both had more stable market prices.

Owning machinery, diversifying one's crop portfolio and renting-in significant acreage were strategies only afforded by the most socio-economically powerful producers. Building grain storage infrastructure was a fourth. On some owned land, the producer of cattle and mangoes also constructed silos to store rice and maize. By doing so, he played the market, holding grains until the shoulder seasons when supply was low and demand high, therefore earning the highest pay per ton. Smallholder or landless producers, in contrast, did not have such infrastructure and were forced to sell upon harvest. I met one family of rice producers that wanted to bypass the three powerful rice companies that dominated local processing markets. They were three generations of landowners, and known to be a socio-economically powerful family. They chose to report to me neither their landholdings nor rented fields, but brought me to tour the construction site of a new rice processing plant. The investment would pay off, they noted, only by processing their harvests and those of a few colleagues instead of going through the powerful mills. Larger producers like these three strategically used rental-fields for production and kept their owned land for less environmentally risky crops and infrastructure enabling higher profits.

Table 4. Survey participants that produced in fields both rented-in and owned in Usocoello and Usosaldaña. Dark highlights of producers that rent-in significantly more than they own, or that rent-in significant amounts of land. ("x" indicates no answer.)

Survey no.	Total area owned (ha)	Time owning principal field(s) (years)	Total area (ha) rented-in	Time renting-in field(s) (years)	District
2	50	20	150	20	Coello

115	140	20	40	x	Saldaña
116	9	15	7.5	x	Saldaña
130	1	5	1	5	Saldaña
132	1.72	10	2.75	30	Saldaña
140	5.5	6	1	5	Saldaña
199	1000	x	900	x	Saldaña
200	10	40	8	4	Coello
201	25	15	180-200	x	Coello
203	2	x	16	x	Coello
205	200	15	1000	30	Coello
206	2	15	18	15	Coello
209	3	8	63	35	Coello
215	63.5	x	35	5	Coello
233	15	16	40	16	Coello
242	2.5	20	1.5	10	Coello
246	32	40	9	1	Coello
265	0.25	15	2	15	Coello
268	2	15	2	5	Coello
274	2	15	7.5	4	Coello
275	1.5	20	19	x	Coello
304	6	9	39	5	Coello

Discussion

Despite the global prevalence of land rental markets, they have received limited attention within agrarian change literature. Examining the relationship between irrigation districts and land rental markets and the particular vulnerabilities experienced within irrigated land rental markets responds to economists' promotion of the coupling as a solution to smallholder poverty (Fonseca Prada 2017), often incorrectly assuming an availability of off-farm employment (Deininger, Jin, and Nagarajan 2008). Quite the reverse, I argue that land rental markets are a form of land control within a broader political-economic process that increasingly excludes small producers, often in areas with few other employment options. Working across literatures of the political ecology of vulnerability with the political economy of agrarian change, this research makes five interventions in the literature, principally in the political economy of agrarian change.

First, contrasting economic narratives that land rental markets tied to irrigation development may increase agricultural productivity and household incomes for low-income producers and so strengthen equity, this research demonstrates the ability to rent-in or rent-out fields does not by itself ensure secure and sufficient household income and is thus not productive of equitable land relations in Tolima. On the contrary, I illustrate through a political ecology vulnerability analysis how Tolima's irrigated land

rental market further reproduces and entrenches existent socio-economic disparities by layering onto 'cumulative vulnerabilities' (Ferring and Hausermann 2019). In Central Tolima, market-based stressors affecting all producers are worsened by the risks of crop loss from environmental factors. Large-scale, landowning producers are able to withstand stresses and ensure overall economic stability through wielding power in irrigation districts to their benefit, expanding production through rentals, diversifying assets across cropping systems, and purchasing infrastructure and machinery to operate economies of scale.

In contrast, many small and landless producers are unable to recover from low market prices or severe pest or disease damage, falling into significant debt to landlords or vendors of seed and inputs. These examples illustrate what Gerber (2014) calls a structure of 'ordinary indebtedness', in which producers are persistently in cycles of paying off and accumulating debt. Bernstein terms this the 'simple reproductive squeeze' (1994: 56) in which costs of production and living increase while prices paid for harvests decrease. Advancing Gerber's, Bernstein's and others' focus, this research shows how environmental vulnerabilities further compound cycles of debt. The chronic and ongoing stresses of debt, insecure tenure arrangements, low market prices, high rental costs, crop loss, and fluctuating water availability and precipitation converge to exclude producers from use of land. Such producers may be unable to recover after a crop loss or be priced out of a field lease, and have few to no other paths to economically profitable agricultural livelihoods. In irrigation districts, exclusion from land access concurrently excludes producers from water access, and hence from land- and water-dependent livelihoods.

I therefore contend land rental markets constitute a mechanism in capital's process of exclusion of more vulnerable producers. A persistent and less spectacular form of land control than land grabs, the case of Tolima suggests through land rental markets capital accumulation works more by means of exclusion than dispossession. The significant number of tenant farmers with little to no owned land in Central Tolima signals that dispossession has already occurred for many. Exclusion in this context occurs not through institution-driven extra-economic means,¹³ but instead through uneven dynamics of social-economic power coupled with vulnerability to environmental variability of water flows and pest damage. As land rental prices rise and landless or small-scale producers are excluded from agricultural production, the more socio-economically powerful producers may increasingly be the only actors capable of paying the rents and using the short-term leases to their advantage.

As a third contribution, the case of Tolima land rental markets further nuances the debates on power relations around land ownership and rentiership. Importantly, the case of Central Tolima's land rental market demonstrates that capital need not depend on land ownership nor on the labor of smallholders. While it is true that land ownership in Tolima affords more financial stability than exclusively renting-in, land ownership is not always desirable. Notably, the most powerful actors, the largest producers of rice and maize, rent-in more hectares than they own. These empirics complicate understandings of land rental markets as "value grabbing" in which land owners exclusively benefit from capturing value through speculative renting (Andreucci et al. 2017; Li 2010). This research instead demonstrates that

¹³ For more on the debate on extra-economic coercion, see Hall 2013, Borras et al. 2018, among others.

larger producers often exploit the land rental market, not land ownership, for further capital accumulation.

Relatedly, empirics on powerful actors renting-in lands, as opposed to literature on rentiership, offer a broader contribution to agrarian change literature by theorizing the increased mobility of capital in its detachment from land. Classic agrarian change theory explains how capital accumulates through ownership of land and the means of production. Certainly, the most powerful landowners and producers in Tolima are now investing in infrastructures of processing plants and own machinery. Yet the land rental market enables capital to detach from land in a different way. Some of Tolima's most powerful producers use the land rental market to diversify their cropping systems against market and environmental stresses. Rental arrangements provide producers flexibility to switch cropping systems in response to regional pest or disease damage, end contracts if rice market prices plummet or diversify cropping systems according to water shortages and availability. Indeed, land rentals constitute what Tad Mutersbaugh (2005) calls a 'just-in-space' arrangement for the most powerful producers to respond to or avoid environmental or economic vulnerabilities.

The small or medium holding producers that cease production and rent out their fields enable capital's detachment from land ownership. The retention of small plots of land by more vulnerable producers is tension discussed in agrarian change scholarship, complicating classic understandings of capitalism's process of the excluded land-based producer becoming an industrial worker. Levien (2012) points to a similar disjuncture in agrarian change understandings of land and livelihoods, noting those excluded from production hold their small parcels of land, keeping some way to earn income as few other opportunities exist. He posits that the retention of land due to limited income options constitutes a contradiction of capitalism. Interview evidence offered strengthens Levien's argument. For example, some small-scale or landless producers continue to cultivate rice despite the high costs of production and low market pay for similar reasons. It is the agricultural system they know, are skilled in, and in which have invested greatly (costs of land preparation, agronomic training, perhaps owning equipment or machinery, establishing market outlets). Transitioning to a new cropping system requires significant time, social, educational and economic resources. Perhaps more importantly, to Levien's point, there are few other income-earning options in these municipalities. Therefore, residents continue to produce rice or maize despite limited profits and high stress, hoping for a season with few crop losses and higher market prices. The other option is to work as a day laborer, which is differently inconsistent, physically taxing, poorly paid and season-dependent. In providing additional case study evidence, my work strengthens Levien's argument.

The findings, however, also extend Leven's work in a meaningful way. The evidence from Tolima suggests the retention of small, irrigated landholdings by small-scale land owners that then rent-out fields enables more powerful actors to strategize against market and environmental variability. In other words, while Levien notes that smallholders keeping land may be a contradiction of capitalism, I contend that, especially in irrigation districts, excluded smallholders keeping their land may indeed be a mechanism of capital accumulation. Producers become landless or are excluded not to become laborers as understood by more traditional understandings of capitalism. Rather they are excluded by more powerful producers who use or extract value from the land, what Saskia Sassen (2010) calls 'advanced capitalism.' Indeed, capitalism may work through the land rental markets, not only through rentiership, or large landowners renting out to smaller producers, but the reverse. More powerful actors rent-in

fields from small landholders. This mechanism permits land rental markets to become conduits of land and water control, through which capital's mobility is less hindered by environmental shocks.

Insights from the political ecology of vulnerability enable attention to the linkages between environmental stresses and land rentals as mechanism of capital accumulation in irrigation districts. Small-scale or landless producers have less production power without machinery and infrastructure and thus less socio-economic power. As such they have less negotiating power within the irrigation district to demand, for example, that water remain in their nearest canal during a water shortage. Moreover, the simplification of irrigated landscapes, such as the focus on maize and rice as priority crops, creates vulnerabilities to widespread pest and disease damage, stresses again particularly difficult for landless or small-scale producers. Variable water flows and pest or disease damage to crops compounds rising rental values and fluctuating market prices, often resulting in deepening disparities in access to land and water. Irrigation megaprojects therefore often result in changes in social power dynamics through shifting patterns of water-land resource access and cropping systems tied to shifts in land use and water distribution channels (author, forthcoming), with impacts on residents' livelihoods.

Finally, the analysis of rental markets as a form of land control in an irrigation district emphasizes the entwined relationship of land and water control and their mutual value production through irrigation development. A vivid example, Colombia's most expensive land rental markets layer onto large-scale irrigation districts. Irrigation development greatly augments land values and, concurrently, big water infrastructure often leads to costs of water, previously a common pool resource, inhibitive for producers with less power due to an enmeshment of factors (class, ethno-racial identities, income, gender and others). By working across land tenure tied to water availability, this investigation brings into conversation the political economy of agrarian change debate of land control and critical scholarship analyzing changing land tenure in response to water control for agriculture (Hidalgo-Bastidas et al. 2018; Woodhouse 2012; Woodhouse et al. 2017). In Andean irrigation scholarship specifically, the case of Tolima contributes a critical view of two established irrigation megaprojects and ongoing capital accumulation in a highly industrialized, irrigated agricultural landscape controlled through land rental markets. The deepening disparities in land and water access and resultant exclusion from land-water based livelihoods serves as a warning, perhaps, for districts still dominated by smallholders and governed communally or those currently under development (author, forthcoming). Broadly, this research contributes to ongoing calls for environmental governance structures and policies that understand land-water as a coupled resource and recognize the differential political, economic and environmental stresses experienced by producers (Chung 2019; Franco, Mehta, and Veldwisch 2013).

Conclusions

Central Tolima irrigators' experiences in the irrigated land rental market directly counter economic narratives of land rental markets as a strategy for equitable rural development and further complicate agrarian change narratives of land control and exclusion occurring through extra-economic means. Integrating insights drawn across the political economy of agrarian change and the political ecology of vulnerability, findings demonstrate the entwined increasing value of land and water within irrigation districts, and land rental markets as a form of land-water control and accordingly, a mechanism of capital accumulation. Furthermore and crucially, this research illustrates the cumulative effects of structural and environmental causes of vulnerability, including environmental and market risks borne disproportionately by landless, small-scale and some medium-scale producers. Already possessing less

socio-economic capital and less social power in the irrigation district and society more generally, the ongoing environmental and market stresses widen disparities in income and equity in resource access and use.

This research points to the exclusion of less powerful producers through land rental markets and capital's evolution in irrigated agricultural landscapes. The empirics presented contribute to recent debates in agrarian change literature indicating dispossession is not the sole mechanism of land-based capital accumulation, but that exclusion from land, and significantly, livelihoods, is another slow violence (Cahill and Pain 2019; Nixon 2011) of capital's movement in rural landscapes. Large-scale irrigation development may create conditions that lead to uneven access to land and water and experiences of precarity. Such conditions are not only political and economic but also interweave with environmental factors of variable water availability or increased climate variability. All of these stressors, combined with rental debt, work to slowly exclude landless and small-scale producers from land- and water-based, agricultural livelihoods. In rural areas with few other income earning options, this exclusion can be extremely destructive to families and individuals' wellbeing.

The analysis presented advances theoretical as well as thematic regional debates, making this work relevant to multiple groups of scholars. With its primary intervention in political economy of agrarian change debates of land control regimes, the case of Central Tolima contributes a critique of land rental markets. Markedly, in working across agrarian change and the political ecology of vulnerability literatures, this research expands political economic studies to also consider environmental vulnerabilities. Simultaneously, the case study demands attention to the connections between land and water control and reinforces other scholars' calls for land and water to be examined as a joined resource. As an evaluation of Colombian, Andean valley irrigation megaprojects, the research joins a historically deep and theoretically expansive body of work critically investigating water, and specifically irrigation, infrastructure in the broader international Andean region. In that conversation, this piece provides analytical tools from the land control debate with explicit focus on land tenure and water access dynamics within land rental markets.

In conclusion, findings point to broader issues of the feasibility and sustainability of agriculturally-based livelihoods in the current rural, big-irrigation development and economic models. Land rental markets in areas of irrigation infrastructure are not a solution to unequal rural relations but instead are enrolled as an important mechanism in capital accumulation. Research attentive to socioeconomic disparities, environmental stresses and capital's development in agrarian landscapes is urgently needed to promote more equitable and sustainable agrarian economies and ecologies.

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